

PACCARB

Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria

Meeting Summary

**15th Public Virtual Meeting of the
Presidential Advisory Council on
Combating Antibiotic-Resistant Bacteria
February 10–11, 2021**

Table of Contents

Day 1	1
Welcome, Overview, and Roll Call	1
Opening Remarks.....	1
Impact of COVID-19 on Antibiotic Use and Resistance—An Update	1
Discussion.....	2
Antibiotic Access and Use Working Group (WG) Introduction and Overview.....	3
Panel 1: Modalities of Care.....	3
Antimicrobial Stewardship at MinuteClinic	3
Antibiotic Stewardship in a Total Virtual Care™ Model.....	4
Connected Care for Food Production Animals.....	4
Discussion.....	5
Panel 2: Populations and Disparities.....	5
Variability in Antibiotic Prescribing: Targets for Improving Antibiotic Use.....	5
Antibiotic Use Through a Health Equity Lens	6
Racial Disparities in Antibiotic Prescribing for Children.....	7
Disparities in Prescribing Based on Provider Density and Socioeconomic Status.....	7
Discussion.....	8
Panel 3: Crops.....	9
Regulating Antibiotic Use on Crops	9
Innovations and Tracking Use of Antibiotics in Tree Crops	9
Strategies for Reducing Antibiotic Use in Tree Crops	10
Antifungal Resistance in Humans and the Environment	10
Discussion.....	11
Public Comments: Innovation Spotlight.....	11
Discussion and WG Next Steps	12
Final Comments and Recess for the Day.....	14
Day 2.....	14
Welcome and Overview.....	14
Roll Call.....	14
Patient Story.....	14
Interprofessional Education (IPE) WG Introduction and Overview.....	15
Panel 4: IPE and One Health	15
Introduction and Framing of IPE	15

Core Competencies in One Health Education	16
Interprofessional Learning, Experience, and Practice (ILEAP)	16
Exemplar IPE Program: The University of North Texas (UNT) Health Science Center at Fort Worth	17
Discussion.....	18
Panel 5: Individual Drivers of Change.....	18
Sustaining IPE Into Practice	18
Enacting Change Through Cooperative Extension.....	19
Patients as Educators: The New Partner in IPE	20
Discussion.....	20
Panel 6: Institutional Drivers of Change.....	21
The Role of IPE in Veterinary Education About AMR.....	21
International Harmonization of Accreditation Standards	21
Institutional Drivers of Change: Opportunity and Evolution in Continuing Education	22
Mechanisms for Furthering IPE and the Role of Government	23
Discussion.....	23
Public Comment.....	24
Discussion and WG Next Steps	25
Final Comments and Adjournment.....	27
Appendix: Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) Members	28
Glossary of Abbreviations	30

Meeting Proceedings

Day 1

Welcome, Overview, and Roll Call

Jomana F. Musmar, M.S., Ph.D., Designated Federal Officer, Advisory Council Committee Manager, Office of the Assistant Secretary for Health (OASH), Department of Health and Human Services (HHS), and Martin Blaser, M.D., Council Chair

Dr. Musmar called the meeting of the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) to order at 10 a.m. ET. Dr. Blaser welcomed the participants and gave a brief overview of the agenda. Dr. Musmar described the Council's establishment and charter. She summarized the rules governing the Council under the Federal Advisory Committee Act and conflict-of-interest guidelines and called the roll. (See the appendix for the list of participants.)

Opening Remarks

RADM Felicia Collins, M.D., M.P.H., FAAP, U.S. Public Health Service (USPHS), Acting Assistant Secretary for Health (ASH), HHS

RADM Collins referred to herself as a pediatrician by training and a public health practitioner at heart. In her long career in public health, she has focused on vulnerable and underserved populations in the pursuit of optimal health for all. RADM Collins said she was humbled to be the acting ASH amidst a worldwide pandemic that has resulted in so much illness and loss of life as well as an unprecedented strain on the health system. She offered gratitude for the health care professionals who support families across the nation.

Antibiotic resistance—like coronavirus—poses a continuing global threat. With thousands of immunocompromised patients in hospitals using ventilators as a result of COVID-19, the need to reduce antibiotic resistance globally is of utmost importance. The National Action Plan for Combating Antibiotic-Resistant Bacteria: 2020–2025 reflects work already in place with state, local, and tribal governments, among others. RADM Collins thanked the Council for its contributions to the plan.

RADM Collins appreciated that representatives from several federal agencies were at this meeting to provide insights on the relationship between COVID-19 and secondary infection and that the PACCARB's agenda includes consideration of disparities in antibiotic prescription and use. Addressing antibiotic resistance requires a coordinated approach across fields and industries, and antibiotic stewardship is more urgent and challenging than ever. RADM Collins noted that the experts who take part in Council meetings play a key role in sharing critical information that affects the ability to combat antibiotic resistance. She thanked them for their dedication and commitment to the United States and beyond.

Impact of COVID-19 on Antibiotic Use and Resistance—An Update

Arjun Srinivasan, M.D., CAPT, USPHS; National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention (CDC)

Dr. Srinivasan summarized CDC's continued investments in managing antimicrobial resistance (AMR). According to CDC data, COVID-19 patients experience bacterial and fungal infections at about the same frequency as patients with other respiratory illnesses. However, COVID-19 results in longer lengths of stay in the hospital, sicker patients, and large patient volumes, all creating opportunities for the spread of antimicrobial-resistant pathogens. Some COVID-19 units have seen outbreaks of antibiotic-resistance infections, including methicillin-resistant *Staphylococcus aureus* (MRSA), underscoring the continued importance of infection prevention and antibiotic stewardship during the pandemic. CDC and its partners have responded to 20 outbreaks of antibiotic-resistant pathogens in COVID-19 units since April 2020.

Use of azithromycin and ceftriaxone in hospitals has increased as COVID-19 infection increased, but nationally, use of broad-spectrum antibiotics in hospitals has not risen. Further analysis suggests the increased use of these antibiotics occurred more frequently at larger hospitals, not all hospitals. In addition, lower hospital admission rates suggest that those who were admitted were sicker and were given more broad-spectrum antibiotics, but small increases are not reflected in aggregate data, which are driven by large hospital systems.

Outpatient prescription of antibiotics in 2020 was lower than 2019 even though outpatient visits have risen since the pandemic started. Nursing homes saw spikes in antibiotic use corresponding with spikes in infection rates throughout 2020. However, when azithromycin, which was likely prescribed for COVID-19 symptoms, is excluded from the analysis, the overall use of antibiotics remains lower in 2020 than 2019.

CDC is collaborating with academic and health care systems to better understand the impact of COVID-19 on antibiotic use and resistance. It is looking more closely at the relationship between *Candida auris* and COVID-19. Dr. Srinivasan said the importance of infection prevention and control cannot be overstated. Health care systems and health departments should build more capacity and resiliency into programs that seek to prevent antibiotic resistance and improve antibiotic use. Even during a pandemic, infection prevention and antibiotic stewardship are effective. Dr. Srinivasan pointed to the potential benefits of increased attention and investment in infection prevention and antibiotic stewardship as a result of the pandemic.

DISCUSSION

Dr. Srinivasan indicated that CDC can gather data to address the following topics of interest to Council members:

- The correlation between increased use of azithromycin in combination with hydroxychloroquine
- Trends in antibiotic use in pediatric populations
- The potential for decreasing unnecessary antibiotic use for urinary tract infections (UTIs) in nursing homes
- The correlation between antibiotic use and shortages of personal protective equipment for hospital workers
- Possible decreases in antibiotic susceptibility testing in hospitals

He noted that CDC would have to explore different databases to better understand how the lack of diagnostic testing affects prescribing practices among providers using telehealth to see patients, but there are important questions to consider around diagnostic stewardship.

Antibiotic Access and Use Working Group (WG) Introduction and Overview

Stephanie Black, M.D., M.Sc., and Locke Karriker, D.V.M., M.S., DACVPM, Co-Chairs

The Antibiotic Access and Use WG is one of two new PACCARB WGs formed in fall 2020 at the request of the OASH. Dr. Black said the WG seeks to investigate differences in perception and use of antibiotics across the One Health spectrum and provide recommendations identifying knowledge gaps that future research can address. Specifically, the WG will look at differences among minority groups and other historically disadvantaged populations, the role that new modalities of outpatient care play in disparities or inequities, and differences among various animal care and plant agriculture settings. The WG will discuss how to encourage stewardship and mitigate any variances in antibiotic prescribing and use in animal care and plant agriculture settings and modalities. The WG plans to present a report and recommendations to the full Council at its June 2021 meeting.

Panel 1: Modalities of Care

Antimicrobial Stewardship at MinuteClinic

Anne Pohnert, M.S.N., FNP-BC, CVS MinuteClinic

MinuteClinics provide low-cost health care for minor health issues in 1,100 CVS pharmacies in 33 states and the District of Columbia. They are primarily staffed by nurse practitioners, along with some physician assistants. MinuteClinics have been accredited by The Joint Commission since 2006. Services cost less than visits to an emergency department or urgent care clinic, and MinuteClinics consistently have high patient satisfaction scores. In some states, MinuteClinic providers offer telehealth visits.

Ms. Pohnert stressed that MinuteClinics “are not an ATM for antibiotics.” All the sites implement antibiotic stewardship guided by evidence-based practices, clinical guidelines, and position statements. Providers rely on clinical workflows embedded in the electronic health record (EHR) to assist with decision making about antibiotics during the patient’s visit. Clinical chart reviews are conducted in alignment with Healthcare Effectiveness Data and Information Set (HEDIS) measures on antibiotic stewardship. Decision support tools include access to a collaborating physician for consultation. Every health care provider has a dashboard that shows individual performance in relationship to HEDIS antibiotic stewardship quality measures. Grand rounds and other educational materials are offered.

On three national quality metrics related to antibiotic stewardship, MinuteClinics exceed targets. The MinuteClinic Interprofessional Antimicrobial Stewardship Colleague Interest Group holds monthly conference calls, engages in journal article review, supports quality improvement projects, and provides communication support, all of which is disseminated to CVS stores across the country. Ms. Pohnert said that supporting the clinical team in having confident conversations with patients is key to making a difference in countering unnecessary demand for antibiotics. MinuteClinic providers are coached on communicating with patients about the appropriate use of antibiotics in ways that resonate with the individual patient.

Antibiotic Stewardship in a Total Virtual Care™ Model

Kristin Dean, M.D., Doctor On Demand

Doctor On Demand offers telehealth services from a sociodemographically diverse roster of board-certified, experienced physicians. Providers participate in continuing medical education, training, and credentialing programs, including antibiotic stewardship training. Most visits involve synchronous video communication, although some are voice only. Clinicians abide by telemedicine guidelines and have integrated options for diagnostic testing.

A 2018 study demonstrated that educating telemedicine providers about appropriate prescribing of antibiotics for acute respiratory infection decreased the number of antibiotic prescriptions. Providers who also had a personalized prescribing dashboard had a significantly larger decrease in prescriptions. Moreover, patient satisfaction scores remained high regardless of whether patients were prescribed an antibiotic. Doctor On Demand has since initiated the dashboard for all providers. The patient satisfaction results are helpful for encouraging antibiotic stewardship in practice. Future studies will evaluate geographic variables across telemedicine.

Like other telemedicine providers, Doctor On Demand saw substantial increases in patient visits when the pandemic started. Most of that growth came from an increase in visits for behavioral health and chronic illness rather than visits for respiratory conditions, including suspected COVID-19 infection. More rural than urban residents took advantage of telemedicine. The number of visits by people living in low-income areas increased somewhat in April 2020.

Dr. Dean said virtual care is safe and effective, but concerns persist about care fragmentation, the disintegration of patient–provider relationships, an increased focus on prescribing antibiotics instead of providing comprehensive care, and subscription business models. Future directions that can address these concerns include clinical quality improvement around antibiotic stewardship, incorporating telehealth into the health care ecosystem, alignment with accrediting bodies, staffing with virtualists trained to develop patient–provider relationships, and Medicare payment policies that support telehealth.

Connected Care for Food Production Animals

Gilbert Patterson, V.M.D., M.P.H., DACVPM, VetNOW

VetNOW supports telehealth services for veterinarians. As in human medicine, COVID-19 advanced telemedicine in the food production industry, said Dr. Patterson. Telemedicine requires a secure platform for exchanging and documenting information used to diagnose and treat patients, with attention to privacy concerns. The food animal industry has unique economic considerations that influence care. Veterinarians must implement workflows across and within several species, and they must balance care for the individual animal with population considerations.

The number of veterinary practitioners is particularly limited in the food animal industry, especially in rural areas. The long distances between farms further restricts availability, and concern about tracking pathogens from one site to another creates additional barriers. Veterinarians considering antibiotic use must take into account the animal's welfare, balancing disease prevention and control with the potential impact on food safety and public health.

Because farms require treatment of a lot of animals at once, they are opportune sites for agricultural antibiotic stewardship research, Dr. Patterson noted.

Telemedicine supports judicious use of antibiotics and bridges gaps in veterinarian availability, especially in the food animal industry. It increases the information available for decision making and helps ensure that decisions are documented in a secure, official medical record. Increased interaction with veterinarians reduces overall antibiotic use and supports more targeted use. Dr. Patterson said veterinary telemedicine would benefit from improved connectivity in rural areas, harmonization with existing medical databases and other veterinary platforms, guidelines for data collection and metrics, and validation and acceptance of its effectiveness.

DISCUSSION

Dr. Dean and Ms. Pohnert both emphasized that coaching providers in effective communication techniques helps them better engage with patients and minimize patient demand for unnecessary antibiotics. Dr. Dean noted that education plays a huge part in decreasing the variation in prescribing practices. Ms. Pohnert pointed out that patient perspectives about antibiotics vary significantly by geographic location. MinuteClinics employ quality measures to standardize care and minimize variation; they also track individual prescribing patterns and target education to those who deviate from the norms.

To further minimize variability at the point of decision making, MinuteClinics use EHRs with clinical workflows that embed guidelines and best practices and offer easy access to clinical decision supports, said Ms. Pohnert. Dr. Patterson said veterinary technology is not fully harmonized to support that approach, but veterinary telemedicine is headed in that direction.

Ms. Pohnert explained that MinuteClinic telehealth providers use diagnostic scoring tools to guide treatment decisions when possible, but in some cases, patients are directed to go to a site for diagnostic testing. Paula J. Fedorka Cray, Ph.D., described a telehealth service that used a mobile health van to collect blood or cultures from patients.

Dr. Dean and Ms. Pohnert said that connectivity poses a bigger barrier than usability in telemedicine. MinuteClinics and Doctor On Demand offer phone visits if video conferencing is not feasible.

Panel 2: Populations and Disparities

Variability in Antibiotic Prescribing: Targets for Improving Antibiotic Use

CAPT Lauri Hicks, D.O., CDC

Dr. Hicks presented data on the wide geographic disparities in antibiotic prescribing in the United States. In regions where overall health is poor, inappropriate antibiotic prescribing is higher. Such prescribing is highest in urgent care facilities (46 percent), followed by emergency departments (25 percent), offices (17 percent), and retail health settings (14 percent).

Pediatricians—in office and urgent care settings—are the least likely to prescribe unnecessary antibiotics to children, while family practitioners, nurse practitioners, and physician assistants are somewhat more likely to do so.

Variation in prescribing among individual clinicians is even greater than variation at the practice level, and efforts should target the individual outliers. Dr. Hicks recommended focusing on (1) primary care providers, nurse practitioners, and physician assistants, because these clinicians are the highest volume prescribers and most likely to prescribe antibiotics inappropriately; (2) urgent care facilities; and (3) respiratory infections. Educating patients and parents is important but not sufficient on its own to drive down unnecessary antibiotic use. Effective clinician-focused interventions include providing data to clinicians that show individual performance in comparison with high-performing peers and coaching clinicians in communication techniques that address patient satisfaction. Moreover, engagement of partners—payers, health departments, health systems, professional organizations, and companies—is critical to success.

Dr. Hicks said the data demonstrate that access to high-performing clinicians is important to equitable care. Ensuring continuity of care and follow up are also vital components of high-quality care.

Antibiotic Use Through a Health Equity Lens

Jeffrey E. Hall, Ph.D., M.A., M.S.P.H., CDC

Dr. Hall put forth a number of questions around equitable access to care and, by extension, appropriate antibiotic use. Access depends on where people seek care, what providers they see, and what those providers prescribe. In some settings, there is little time to build the kind of patient-provider relationship that is essential to health. Feeling unheard affects whether patients take medications and take them correctly.

Paying attention to equity requires deeper thinking about where people seek care, what the visits involve, and the circumstances that affect health and healing outside the care setting—such as the ability to take medications as directed or to stay home and rest. Dr. Hall proposed exploring differences around antibiotic use linked to social, economic, and environmental disadvantages, such as race or ethnicity, social or economic status, or where one resides. Further questions should assess environmental risk factors, hazardous exposures, and behavioral stressors and constraints, as well as administrative strategies for limiting antibiotic misuse that pose barriers in an inequitable way. Community characteristics and beliefs can reveal differences in antibiotic use. For example, some people stop taking antibiotics when they feel better because they believe this approach limits the impact of the drug. Some studies have linked material deprivation with antibiotic resistance.

Variability in access is tied to vital conditions for community health, such as well-paying jobs with health insurance benefits and availability of services to manage chronic conditions and prevent them from worsening. Differences in health outcomes linked to quality of care, availability of patient-centered care, and communication should be assessed to understand antibiotic use variability. Specifically, Dr. Hall noted that the power dynamics of the patient-provider relationship affects whether patients feel they can request or reject a prescription and whether providers feel they can encourage or deny a regimen. He also suggested looking at factors that influence adherence to care directions, such as obtaining a prescription. More broadly, Dr. Hall suggested assessing the socioeconomic consequences that result from variations in appropriate use of antibiotics, such as lost earnings, missed school days, and poorer quality of life. He concluded that providers and systems can explore these health equity

considerations, which correlate with the World Health Organization's (WHO's) priority public health conditions framework, and advance health equity through informed antibiotic use and stewardship.

Racial Disparities in Antibiotic Prescribing for Children

Jeffrey S. Gerber, M.D., Ph.D., Children's Hospital of Philadelphia

At least half of the antibiotics prescribed to children for acute respiratory infections are never needed. Studies demonstrate that nonwhite children are substantially less likely to be prescribed antibiotics in both primary care pediatric practices and emergency departments. Telemedicine should, in theory, provide care comparable to conventional health settings without exacerbating health care disparities. However, virtual care requires internet access and enabled devices, digital literacy, and, in some cases, health insurance—all of which factor into inequitable care. A study of telemedicine use during the COVID-19 pandemic found that Black and low-income people were less likely than others to use the video component, suggesting they face barriers to technology access.

An assessment of direct-to-consumer telemedicine found that patients gave higher satisfaction scores when they were prescribed antibiotics, and the more antibiotics prescribed, the higher the satisfaction. In fact, antibiotic prescription was the only strong predictor of high patient satisfaction. Dr. Gerber acknowledged that Doctor On Demand saw high patient scores among those who did not get antibiotics; he suggested that in other telemedicine settings, providers are not having effective conversations with patients who do not need antibiotics. Another study found that direct-to-consumer telemedicine providers were more likely than urgent care centers and primary care providers to prescribe antibiotics for children with upper respiratory infections and least likely to follow prescribing guidelines.

Although many children receive unnecessary antibiotics, Dr. Gerber concluded that the disparities in antibiotic prescribing by race and ethnicity are particularly troubling because the outcomes are not clear, so the impact of the disparities might reveal problems beyond antibiotic stewardship. Further evaluation is needed to assess mechanisms and outcomes, with the goal of ensuring appropriate and judicious antibiotic prescribing for all.

Disparities in Prescribing Based on Provider Density and Socioeconomic Status

Eili Klein, Ph.D., M.A., Johns Hopkins University

Dr. Klein said that in addition to disparities across states in antibiotic prescribing and use, differences can be seen within states. Geographic variations in antibiotic prescribing are driven by several factors:

- Socioeconomic differences, such as education, income level, health insurance status, and access to childcare
- Structural differences, such as physician density and remuneration, antibiotic costs, and competition
- Cultural differences, such as prescribing norms and patient expectations
- Incentives for patients, clinicians, and hospitals

A study from the 1980s found that reducing the price that patients paid for antibiotics increased their use, and the effects were more pronounced among poorer families. Another study demonstrated that when certain antibiotics were covered at no cost to the patient, not only did overall antibiotic prescribing increase, but clinicians prescribed more of the covered antibiotics than those not covered. An investigation of the relationship between provider density and prescribing found that having more providers available per capita was associated with more prescriptions per capita. It also found that the higher the percentage of the population with a college degree, the higher prescribing rates were, likely because those with college degrees are more likely to have health insurance through an employer. Dr. Klein pointed out that in Europe, higher levels of education are associated with lower prescribing rates.

In poorer communities, more people get care at clinics or urgent care facilities, which leads to higher prescribing rates but not more physicians per capita. In wealthier communities, the presence of clinics augments the prescribing rates of clinicians. Dr. Klein noted that urgent care facilities and clinics provide more access in some areas, but their prescribing rates may be higher than appropriate. In higher-income areas, prescribing practices might be driven by competition with clinics and urgent care centers.

DISCUSSION

Dr. Hicks said CDC has talked with several professional organizations about integrating antibiotic stewardship education into curricula, training, certification, and conferences for nurse practitioners, physician assistants, and other midlevel health care providers. It is very challenging to get antibiotic stewardship added into the already-packed curricula for medical, pharmacy, and nursing students. Dr. Hicks said the best opportunities lie with accreditation organizations and certifying partners that provide continuing education and testing.

Regarding the persistent variability in antibiotic prescribing by geographic location, Dr. Hicks said the drivers vary. For example, urgent care settings contribute to some unnecessary prescribing. Providers who see patients across the life span tend to prescribe in a similar way for all ages. The geographic differences also reflect cultural differences in patient expectations, so social norms must change where inappropriate prescribing is very high. The fact that counties with higher minority populations have higher prescribing rates might be a function of lack of access to high-quality clinicians.

Dr. Hicks said CDC is working with health departments on how to give individual providers feedback about their prescribing rates in comparison with their peers—an approach that reduces unnecessary antibiotic prescribing. Antibiotic stewardship data are available through IQVIA, state Medicaid programs, and state payer organizations.

Jason Newland, M.D., M.Ed., noted that little attention has been given to previous findings that Black children are less likely to be diagnosed or prescribed antibiotics. Dr. Hall said interpersonal characteristics might affect prescribing. For example, there are differences in access to patient-centered care, which promotes communication and empathy. Certain groups of African Americans, in particular, are less likely to feel comfortable advocating for their own care. Organizational factors might be at play; where providers have a heavy patient load, they might be less likely to give personalized attention to each patient.

James Cleeman, M.D., said antibiotic use without a prescription can result from sharing antibiotics, selling leftover antibiotics, and buying antibiotics at unregulated markets, for example. He called for more research on the phenomenon and its relationship to the cost of prescriptions and distrust of the health care system. Helen W. Boucher, M.D., FIDSA, FACP, recommended creating incentives for providers to achieve “high-quality prescriber” status.

Dr. Gerber said clinicians might benefit from more training in communicating with patients and from thinking more deeply about ingrained biases. Dr. Hall noted that tackling systemic racism requires more than one approach, and the barriers are site-specific. For example, efforts to address maternal mortality rates must take into account organizational factors, such as the size of the care team, the provider’s patient load, and patients’ interactions with front-line staff, among other variables.

Panel 3: Crops

Regulating Antibiotic Use on Crops

Susan Jennings, U.S. Environmental Protection Agency (EPA)

Ms. Jennings said that under federal statute, antibiotics used in crops are considered pesticides. EPA evaluates the potential for adverse effects of pesticides, which includes the potential development of antibiotic resistance. Bacterial pest pressure on agricultural crops is increasing, which leads to calls for new pesticides. Currently, three active ingredients are registered for use as antibiotic pesticides, and their use is critical to agricultural health.

Risk assessments for antibiotic pesticides consider the same factors as the risk assessments for conventional pesticides, taking into account human and environmental health, costs, benefits, and alternatives, but antibiotic pesticide risk assessments also consider the potential for resistance, which requires consultation with the Food and Drug Administration (FDA), CDC, and the Department of Agriculture (USDA). Assessments take into account the method of delivery and the crop on a case-by-case basis. Although a lot of data exist about the environmental risks of pesticides, none are available for antibiotics. EPA relies on FDA’s guidance for the use of antibiotics in animals, adjusted for agricultural products. Through consultation with other agencies, EPA discusses the validity of its assessment process, risk mitigation options, and monitoring approaches.

Ms. Jennings said EPA can impose limits, such as requiring monitoring for antibiotic resistance or cross-resistance, at the time a product is registered in case the science changes. It can also evaluate products more frequently if needed or specify a review period at the time of registration.

Innovations and Tracking Use of Antibiotics in Tree Crops

Kerik Cox, Ph.D., Cornell University

Dr. Cox outlined how the three antibiotics approved by EPA—oxytetracycline, streptomycin, and kasugamycin—are used in tree crops to prevent devastating diseases. Antibiotics are effective for treating bacteria that attack the outside of the plant but not when bacteria get into the plant tissue. Growers combine decision support systems with weather data to determine when

to treat crops within a narrow window of opportunity. They may also use antibiotics after a traumatic event that leaves crops potentially exposed to internal bacteria, such as a hailstorm.

Dr. Cox said applying antibiotics on the basis of forecasting (specifically for fire blight) is the most cost-effective and responsible approach. Forecasting helps growers determine the timing and favorability of environmental conditions for blossom blight infection and enables them to use antibiotics at the most advantageous time. Dr. Cox explained that information gathered from tracking specific strains of bacteria and AMR informs geomapping to assist with decision making. Tracking data suggest that AMR to certain strains of *Erwinia amylovora* (fire blight) can be transported.

Strategies for Reducing Antibiotic Use in Tree Crops

George Sundin, Ph.D., Michigan State University

Dr. Sundin reiterated that growers have a limited window for using antibiotics to treat tree diseases. He pointed out that kasugamycin is not widely used. Notably, the most popular varieties of tree crops (e.g., Gala and Fuji apples) are the most susceptible to fire blight. Trees that have resistance genes—such as crabapples—generally do not produce viable fruit. Dr. Sundin predicted it would take 20 years or more using traditional approaches to breed a Gala with a crabapple to create a fruit that tastes good.

With USDA funding, Dr. Sundin is studying how to speed up the breeding process to create a high-quality fruit that is genetically resistant to fire blight. The approach inserts a transgene into a breeding line early in the process and then breeds it out at the end, so that the fruit is not transgenic but has resistance genes. Another researcher is identifying the genes in citrus fruit that are susceptible to canker and silencing them using CRISPR technology to create canker-resistant citrus fruit, and others are taking a similar approach to prevent citrus greening disease. Dr. Sundin concluded that the research could result in viable crops within 10 to 20 years for apples and in less than 10 years for citrus.

Antifungal Resistance in Humans and the Environment

Melanie Ivey, Ph.D., The Ohio State University

Dr. Ivey explained that fungicides are commonly used around the world for fruit, vegetable, and nut crops. Currently 13 classes of fungicides are available for crop protection, and significantly fewer for veterinary and human medicine. Azoles are the most widely deployed single group of fungicides in agriculture and human medicine. *Aspergillus*, a common environmental fungus, causes disease in plants and can produce toxins deadly to humans and animals. The most common form in humans, *A. fumigatus*, is becoming increasingly resistant to azoles, posing a global health threat. Azole resistance in clinical isolates of *A. fumigatus* has been directly linked to the intensive use of azole fungicides in agriculture.

A study involving genetic analysis of azole-resistant *A. fumigatus* in tomatoes found 695 *A. fumigatus* isolates, of which 109 were resistant to one or more antifungal. None were resistant to all three of the antifungals, and a small percentage were resistant to two of them. The newest product, posaconazole, generated the least resistance. Through further analysis, researchers were able to identify 694 of the 695 isolates by morphology. The next step will be sequencing to identify potential mutations that could be the basis for genetic resistance. Dr. Ivey said the field

is just beginning to investigate the links between antifungal resistance in the field and in clinical settings. The goal is to reduce the potential for resistance development to support continued use of azoles for crops in a sustainable way.

DISCUSSION

Dr. Ivey noted that the detection of multi-azole-resistant *Aspergillus* in tulips grown in the Netherlands was the impetus for research in the United States. She added that there is interest in looking at water and soil to assess the potential impact of resistance on human health. Ms. Jennings said EPA labeling requires farm workers to wear protective gear, and the agency has not heard reports of resistance in humans related to antibiotic pesticide use.

Ms. Jennings said that antibiotics are not widely used in agriculture with the exception of treatment for citrus greening. EPA requires growers to monitor and test for an array of plant and human pathogens. Ramanan Laxminarayan, Ph.D., M.P.H., called for more detailed information on the amount of antibiotics used, particularly to treat citrus canker. Ms. Jennings said EPA has a difficult time getting such information. Dr. Ivey said 0.2 percent of the market share of antibiotics is used on crops.

Paul Plummer, D.V.M., Ph.D., DACVIM, DECSRHM, said there is some interest in injecting antibiotics into trees, but it is not allowed under the current labeling. Ms. Jennings noted that growers can deviate from the application methods described on a label if they follow all the other parameters, such as number of acres treated and dosage. Labeling is stricter for use of antibiotics on trees, so alternative applications methods might not be feasible. A lot of research is looking at optimal ways to apply pesticides, particularly antibiotics, such as a smart sprayer that adjusts the amount of pesticide based on the tree size. Such mechanisms complicate the issue of following labeling parameters. Dr. Ivey said the smart sprayer substantially minimizes the amount of pesticide that misses the plant and drifts away. Dr. Cox added that injecting individual trees is prohibitively time-consuming.

Public Comments: Innovation Spotlight

Dr. Musmar introduced a new public comment opportunity open to all those with relevant new and emerging technologies they wish to present to the Council.

Devasena Gnanashanmugam, M.D., of Cepheid, a molecular diagnostics company, described how its GeneXpert® technology uses polymerase chain reaction for pathogen detection and, in some cases, simultaneous detection of resistance. Using the 10-color assay instrument (earlier versions used a six-color assay) plus melt curve technologies, Cepheid developed a cartridge that can identify extensively drug-resistant tuberculosis, facilitating treatment and preventing further AMR. Another cartridge identifies resistance to carbapenems.

Lucy S. Tompkins, M.D., Ph.D., of Stanford University School of Medicine noted that blood culture contamination is associated with excess antibiotic treatment, risk of *Clostridioides difficile*, and other antibiotic-resistant infections. About 25 to 50 percent of all positive blood cultures contain skin contaminants. The Steripath® Gen2 initial-specimen diversion device, manufactured by Magnolia Medical, sequesters the initial 1.5 mL of blood drawn so that the remaining blood collected does not have microbial contaminants. Use of the device in a quality

improvement study at Stanford eliminated blood culture contamination and substantially decreased central-line-associated bloodstream infections. Dr. Tomkins concluded that the Steripath device can reduce excess antibiotic therapy, improve diagnoses, and improve patient safety and outcomes.

Ross Youngs, CEO of Biosortia, said the major limitation to discovering new potent drug-like chemistry is the substantial lack of direct access to the chemistry of microbes, which has been limited to microbes that can be grown and studied in the laboratory. Biosortia intends to build the world's largest library of microbiome-derived compounds by leveraging its microbial harvesting platform to sample and mine aquatic microbiomes at unprecedented scales in sustainable and environmentally friendly approaches. New microbiome mining tools can accelerate the advancements of microbiomics. New data sets will close persistent gaps in understanding and ultimately create efficiencies in discovery. Microbiome mining will drive acceleration and efficiencies in preclinical development while creating a wealth of new products, new businesses, and a competitive advantage for the United States.

Kalvin Yu, M.D., of Becton Dickinson & Co. described a technology platform that provides near-real-time insights about COVID-19 patients and antimicrobial misuse or overuse. The technology shows total antimicrobial use in a hospital among patients who do or do not have COVID-19, providing high-level awareness of prescribing patterns, and allows users to drill down by subgroups of antimicrobials. It also shows use patterns across hospitals to help gauge the potential overuse of specific agents and need for antimicrobial stewardship education. Becton Dickinson is collaborating with the federal government to provide a different interactive platform that depicts national trends in COVID-19 cases, using a database of more than 2.6 million tested acute care patients. The platform can reveal antimicrobial use trends that are helpful for public health and outcomes in terms of mortality, intensive care unit stay, length of stay, and severity of illness. The information should help public policymakers in forming guidelines, especially in light of the new variant strains of coronavirus spreading.

Discussion and WG Next Steps

Stephanie Black, M.D., M.Sc., and Locke Karriker, D.V.M., M.S., DACVPM, WG Co-Chairs

Dr. Karriker observed that more data are needed to facilitate environmental assessment research. Just as Dr. Hall challenged clinicians to think about the inequities in patient-provider interactions, Dr. Karriker said there are parallel issues in veterinary health. He also noted that veterinary telehealth has different drivers and different impediments for companion animals than food animals, which the WG should take into account.

Dr. Black hoped the WG would consider some of the key concerns raised around telemedicine, such as the lack of regulation, the potential for care fragmentation, the need for diagnostic testing, and variance in antibiotic prescribing. She hoped the WG would explore financial incentives that might drive overprescribing and the issue of people self-diagnosing and obtaining antibiotics online.

Dr. Blaser noted that Doctor On Demand and MinuteClinic have made progress in curtailing unnecessary antibiotic use. He challenged all providers to emphasize good antibiotic stewardship

over patient satisfaction scores. Dr. Blaser said the field needs to collaborate to develop best practices, educational strategies, and incentives to move forward. He also suggested looking at whether agriculture should be restricted to using antifungals that are not used in human medicine in light of increasing antifungal resistance.

Christine Ginocchio, Ph.D., MT, reminded the Council of its previous recommendation to look at drug candidates that were discarded because they were not effective in humans; such compounds could have a role in animal and agricultural health. Greg Frank, Ph.D., suggested looking more closely at specific areas of health care, such as long-term care and inpatient settings, to see whether they experience the same issues as outpatient settings.

Dr. King said the presentations underscored the influence of culture on behavior, which may reveal opportunities for interventions. He noted that pharmacists might be more closely connected to patients in less populated areas, so they might be called on to play a bigger role in antibiotic prescribing. Dr. King pointed out that Walmart is opening veterinary health practices, creating a new frontier for retail animal health care. He wondered whether any data show correlations between anti-vaccination stances and the use or avoidance of antibiotics.

Sara E. Cosgrove, M.D., M.S., sought more information about the spillover effects of antibiotics used in agriculture. She also hoped to learn more about the financial issues growers would face if they stopped using antibiotics and started growing more disease-resistant crops. Dr. Cosgrove pointed out that MinuteClinics employ prescriptive algorithms and monitor provider antibiotic prescribing practices closely. Telehealth and urgent care settings have high rates of unnecessary antibiotic prescribing, likely reflecting less monitoring and oversight.

Dr. Boucher highlighted the need for diagnostics. More research is needed on conditions for which the decision to use antibiotics is not clear cut. The choice of antibiotic and duration of use are also important factors in antibiotic stewardship. States' efforts to find data to support equitable COVID-19 vaccination should bring to light the need for a national approach to data collection.

Kent E. Kester, M.D., FACP, FIDSA, FASTMH, noted that MinuteClinic and Doctor On Demand use the kinds of interventions that the Department of Veterans Affairs has long championed—dashboards and feedback loops at the provider, practice, and facility level. He proposed highlighting these approaches as best practices.

Elizabeth Dodds Ashley, Pharm.D., M.H.S., FCCP, BCPS, hoped that lessons could be learned from nursing homes during the COVID-19 pandemic about how to drive down inappropriate antibiotic use, particularly for UTIs. She suggested building on consumers' interest in antibiotic-free meat by educating the public about produce that is less likely to require antibiotics. Dr. Plummer said good controls are in place to ensure that people are not exposed to a lot of antibiotics through foods that have been treated. However, the question of environmental impact of antibiotic use in food production persists. It is important to differentiate these two issues.

Jay Garland, Ph.D., said overall agricultural antimicrobial use is increasing, despite some techniques to use antifungals more precisely. The potential impact on humans should be a key focus.

Dr. Cray expressed concern about the lack of mechanisms for safely disposing of unused household drugs.

Michael D. Apley, D.V.M., Ph.D., DACVCP, called for more transparent data around EPA recommendations on antibiotic use. He wondered whether there are quality control and break point data to ensure that terms like “resistance” and “susceptibility” are accurately used in plant agriculture. Dr. Apley concluded that older EPA labels might not reflect current best practices.

Final Comments and Recess for the Day

Martin Blaser, M.D., Chair

Dr. Blaser thanked the participants and presenters and recessed the meeting for the day at 3:54 p.m.

Day 2

Welcome and Overview

Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair

The meeting began at 10 a.m. Dr. King welcomed the participants and outlined the agenda for the day.

Roll Call

Jomana F. Musmar, M.S., Ph.D., Designated Federal Officer, Advisory Council Committee Manager, OASH, HHS

Dr. Musmar reiterated the rules of engagement and called the roll.

Patient Story

Michael McVey

Mr. McVey said he represented the human face of AMR, and his story demonstrates that any sequence of events can become a disaster or a miracle. A retiree, Mr. McVey said he visited his doctor for regular checkups but had no concerning health conditions. One week after adopting a puppy, he experienced severe symptoms and was diagnosed first with stomach flu, then hospitalized for failing kidneys.

Mr. McVey’s sister-in-law had been reading about AMR and suggested the puppy might have played a role in his illness. His infectious disease specialist contacted CDC to discuss his case and eventually diagnosed a multidrug-resistant *Campylobacter* infection. CDC suggested administering intravenous antibiotics that were not commonly available and were only shipped in small amounts to hospitals. Mr. McVey’s health care team reached out to procure the antibiotics from various hospitals. Sequencing by CDC revealed that Mr. McVey and the puppy carried the

same infection. It was later learned that he was one of about 100 people across 17 states who were infected, all related to infected puppies from pet stores.

After 30 days in the hospital and a stomach resection surgery, Mr. McVey was finally released. He considers the experience to be an example of miraculous luck, because his care providers were exceptional and because CDC was accessible to them.

Interprofessional Education (IPE) WG Introduction and Overview

Elaine Larson, Ph.D., RN, and Paul Plummer, D.V.M., Ph.D., DACVIM, DECSRHM, WG Co-Chairs

Dr. Plummer said the ASH tasked the new WG with investigating how IPE can be used to improve antibiotic stewardship and infection prevention curricula. The WG was asked to make recommendations on incorporating IPE to strengthen training, national and state board certification and accreditation, and continuing education of health science professionals. The WG seeks to describe the status of IPE for antibiotic stewardship and infection prevention and explore curricula for all aspects of health care, animal care, and agricultural provisions.

Dr. Plummer shared the draft outline for the WG's report, which it plans to provide with recommendations to the full Council at its June 2021 meeting. It will cover a shared vision for an IPE/One Health framework that encompasses lessons learned from existing IPE programs and how to move from IPE to One Health. The report aims to address adoption of IPE in professional schools, continuing education, and federal government. It will also speak to defining and monitoring outcomes.

Dr. Larson said several studies confirm that the lack of coordinated care and collaboration are associated with poor patient outcomes, including a higher risk of mortality. It has been proposed that a collaborative framework could integrate antibiotic stewardship and infection prevention using a team science approach that promotes mutual trust, effective conflict management, accountability, common understanding, and open communication.

Panel 4: IPE and One Health

Introduction and Framing of IPE

Patricia Cuff, M.S. M.P.H., National Academies of Sciences, Engineering, and Medicine

Ms. Cuff said many so-called multidisciplinary activities would be better described as “parallel play” because they lack integration. IPE involves two or more professions working together toward a common goal and can take many forms, including active co-learning in simulated environments and real-world experiential learning combined with classroom learning and group reflection. Ms. Cuff said even professionals seeking continuing education would benefit from group exercises that encourage working toward a common goal. IPE does not have a strong foundation in educational settings, but students can learn from good interprofessional teams.

Effective IPE faces challenges of logistics, such as coordinating schedules and accommodating students at different levels of training. Health professionals use different terminology, making it difficult to find a common language. Each health profession has its own culture, and the distinctions are even greater across human, animal, and environmental settings. Power

dynamics—or turf conflicts—play a role; those with the most funding often wield the most power.

To overcome language barriers, Ms. Cuff recommended learning from and with other sectors throughout the continuum of education. IPE should strive for a common culture of respectful engagement, with a flat hierarchy, no blaming, and awareness of unfunded mandates. Turf conflicts can be mitigated by ensuring equal funding across professions and by cultivating champions who can speak the languages of human, animal, and environmental health.

Ms. Cuff proposed that IPE learning opportunities focus on four areas: behavior, data collection and analysis, biology and pharmacokinetics, and advocacy. Each can be explored at any level, from students in foundational education to practicing professionals. The Minnesota One Health Antibiotic Stewardship Collaborative provides an example of IPE across professions and sectors. The collaborative has engaged in activities such as field trips to learn about dairy farming practices and environmental water sampling, joint presentations at the Minnesota State Fair, and support for graduate student research projects to collect data and advocate for behavior change.

Core Competencies in One Health Education

Jonna Mazet, D.V.M., M.P.V.M., Ph.D., University of California, Davis

Dr. Mazet described the results of a broad survey of One Health education in the United States, which defined One Health as a collaborative, respectful approach at the intersection of human, animal, plant, and environmental issues. The survey found 45 academic degree programs teaching this approach. About 75 percent of programs had a strong focus on epidemiology and environmental health. Plant health, AMR, and law were poorly represented.

Dr. Mazet and colleagues assessed the programs and identified three core competencies of One Health education: health knowledge; global and local issues in humans, animals, plants, and the environment; and professional characteristics, including communication, respect, collaboration, and coordination. A survey of graduates of One Health programs revealed that graduates and employers ranked highly (1) interpersonal communication and communication with nonscience audiences and (2) the ability to work in and manage cross-disciplinary teams.

The University of California, Davis, hosts the oldest One Health education program in the country. Its undergraduate global disease biology program, which emphasizes soft skills and interdisciplinary respect, is extremely popular. The university is also partnering with the Africa One Health University Network and the Southeast Asia One Health University Network to train the next generation of leaders. Both of those agencies are developing One Health Workforce Academies, which support communities of learning and promote experiential learning. Dr. Mazet gave some examples that highlighted how the One Health approach contributes to identifying genes of resistance and how they link across human, animal, and environmental health. She noted that human and animal health are often well represented in One Health but more expertise in environmental health is needed.

Interprofessional Learning, Experience, and Practice (ILEAP)

Catherine A. Demko, Ph.D., Case Western Reserve University

Dr. Demko summarized the ILEAP program, which seeks to better link learning and assessment, connect foundational training with clinical skills, and foster development of team skills in practice-based experience. ILEAP participants are rigorously prepared through a formal, team-based, onsite curriculum that guides learning, provides experience, and ensures students contribute value to patients' overall care.

Evaluation takes place throughout the program with a combination of quantitative and qualitative assessments, self-report, and direct observation. One key component of evaluation is the mechanism for direct observation of team interactions (DOTI). The DOTI tool assesses 15 observable team skills in four domains—task communication, interpersonal communication, team process, and roles and leadership. The DOTI tool can distinguish low from high team performance and capture change over time. The ILEAP model begins with faculty and coach training to ensure all speak the same language, followed by a readiness curriculum, opportunities to practice using simulations, onsite team skills curriculum, and formative feedback and summative assessment. The DOTI tool is applied at every stage to rate participants. The ILEAP program focuses on those in the first year of professional training but the principles can be applied to advanced learners and teams through continuing education.

Dr. Demko outlined how antibiotic stewardship might be embedded into an IPE curriculum. For example, the team could bring together students from the four One Health domains with the common goal of discussing AMR and antibiotic stewardship while practicing in a simulated environment. ILEAP is developing a website with IPE information and worksheets.

Exemplar IPE Program: The University of North Texas (UNT) Health Science Center at Fort Worth

David Farmer, Ph.D., LPC, LMFT, FNAP, UNT Health Science Center at Fort Worth

Dr. Farmer said there is an assumption that students entering the clinical environment will know how to function within an interprofessional team or that they will learn, but students do not necessarily have good models of effective interprofessional collaboration. In 2012, UNT opened a department of IPE and practice, building on its relationships with neighboring universities. The department provides centralized IPE across 11 health professions through workshops over four semesters aimed at students in year one or two of their degree programs. The department has more than 40 interprofessional faculty facilitators to help with the workshops, which cover the IPE core competencies. At the same time, each program identifies interprofessional considerations that are integrated into the curriculum.

Dr. Farmer gave some examples of how students engage in IPE in practical settings and get feedback on their work as a team. In some cases, IPE learning also helps expand the capacity of clinical providers to conduct outreach and education. UNT now offers online microcredential training for faculty and preceptors, who need to learn how to integrate the approach into their classrooms and practice settings. In response to the COVID-19 pandemic, IPE moved online, with good outcomes so far. Instead of using the in-person team training module from the Agency for Healthcare Research and Quality (AHRQ), UNT students now play the game Minecraft to practice collaborating online, and the results are similar to those of in-person exercises.

In closing, Dr. Farmer said UNT is among the founding partners of the Texas IPE Consortium, representing 28 private and public academic institutions. This community of practice facilitates sharing of information and strategies.

DISCUSSION

Dr. Larson asked the panelists to discuss when and how IPE should be initiated and what changes are needed to promote it. All said IPE should begin as early as possible in a student's education. Dr. Mazet noted that having champions is critical. She also said it is not necessary that everyone be able to speak each other's language if participants have respect for each other and are willing to ask questions. Encouraging respect could easily be incorporated into every educational approach at every level.

Dr. Cuff emphasized the importance of having well-functioning teams to learn from in practice. Understanding the roles of the others on the team is necessary for ensuring a warm handoff and for knowing who can answer questions. Dr. Farmer added that educators must be trained to think beyond their own fields and consider connections with disciplines outside of health.

Dr. Plummer requested input on how better to integrate virtual simulations. Dr. Demko said students are adept at using technology and, since the COVID-19 pandemic, have had a lot of practice with virtual meetings and conversations.

Dr. King appreciated that mutual respect and ethics were baked into the core competencies. He emphasized the importance of professionalism and professional identity, which human medicine is beginning to address but veterinary medicine is not. Dr. Cuff noted the need to understand the roles of leadership, co-leadership, and followership. When a professional's expertise is needed, the professional should step forward to lead or co-lead; in other cases, that person should step back and let others come forward.

Dr. Farmer added that teaching teamwork contributes to professional identity and remains a challenge. The Texas IPE Consortium members agreed to adopt the AHRQ module on teamwork, with the goal of integrating it into all health education programs in the state. Other states have also created IPE collaborations. Dr. Demko said the National Center for Interprofessional Practice and Education is a good resource and can provide leadership and support for collaboration and information sharing, and Dr. Cuff added that it holds an annual conference with lots of peer learning activities. Via chat, Dr. Mazet said the One Health Workforce Academies are a good example of international collaboration.

Panel 5: Individual Drivers of Change

Sustaining IPE Into Practice

Maria Wamsley, M.D., University of California, San Francisco (UCSF)

The challenges in health care, highlighted by the pandemic, demonstrate the need to train health care providers in collaboration, systems design, leadership, and quality improvement. Students who receive IPE during early training are often disappointed by the lack of interprofessional practice in the clinical environment. Dr. Wamsley said IPE and collaborative practice must develop together, which requires a culture shift.

UCSF implemented a Department of Veterans Affairs model to improve care by standing up interprofessional teams. The initiative yielded impressive results in increased learner competency, enhanced trainee and staff perceptions of collaborative care, and improved patient outcomes. Dr. Wamsley called for more investment in such initiatives, dissemination of best practices from these efforts, and incentives for systems to adopt best practices.

IPE in the workplace should be formalized, structured, and explicit. Dr. Wamsley suggested exploring whether interprofessional teams value learning and expect team members to learn from each other, what facilitates or prevents team learning, and how to enhance learning opportunities, such as team huddles. Teams should have time to reflect together on processes. All these steps require leadership that recognizes and promotes the importance of collective learning and faculty and staff who are skilled in recognizing and capitalizing on interprofessional teachable moments.

At UCSF School of Medicine, all learners take part in an 18-month clinical program (one day per week) through which students work with clinic staff and faculty coaches to design and implement a systems improvement project. Participants said they learned about interprofessional roles and responsibilities, gained an appreciation for the knowledge and expertise of other health care providers, and recognized how interprofessional collaboration can optimize patient care. Dr. Wamsley said attention must focus on how to prepare the workplace to better promote learning and collaboration. Sharing physical space helps, and the pandemic makes that challenging, but there may be opportunities to leverage technology to compensate for the distance. Future efforts must clearly define the scope of practice and supervision for trainees and focus on the value they bring to care.

Enacting Change Through Cooperative Extension

Roger Rennekamp, Ph.D., Cooperative Extension System, Association of Public and Land-Grant Universities

The Cooperative Extension System is the community outreach arm of land-grant universities, jointly funded by governments at all levels, grants, gifts, and user fees. The system has 3,100 extension offices serving every county in the nation, with 32,000 employees. Some historically Black colleges and universities and Tribal colleges also take part in the system.

Extension offices are staffed by professionals who live in the communities they serve, so they develop trust among residents, which enables them to communicate science-based knowledge that speaks to local, state, and national issues. Dr. Rennekamp emphasized that extension offices play an increasingly important role in ensuring that citizens are scientifically literate. The system facilitates partnerships across campuses to link schools of public health, pharmacy, agriculture, human medicine, veterinary medicine, social work, and nursing. Extension offices work with local health departments, support local coalitions, and help coordinate federal and national grant programs in their communities.

Dr. Rennekamp said the Cooperative Extension System could play a role in IPE through its rapidly expanding health-related work, its growing focus on the One Health approach, and its eXtension web-based platform, which hosts professional development tools and communities of practice. County extension offices have hosted IPE opportunities, such as student practica, CDC public health field training, and continuing education for physicians and public health providers.

With The Ohio State University, the extension program launched Generation Rx to educate about efficient, effective, safe use of antibiotics. Extension offices also support 4-H programs, such as youth health ambassadors.

Patients as Educators: The New Partner in IPE

Sue Sheridan, M.I.M., M.B.A., DHL, Society to Improve Diagnosis in Medicine

Patients play an important role in IPE by contributing their lived experience. Ms. Sheridan described the cascade of failures of communication and coordination that led her child to suffer brain damage because the jaundice he developed as a newborn went untreated and progressed to kernicterus and eventually to cerebral palsy. Ms. Sheridan believes the outcome would have been different if health care providers had listened to her instead of dismissing her as a nervous, first-time mother, and if the providers had communicated appropriately with each other about their observations and test results and followed up on them.

Ms. Sheridan asked how medical students and professionals are expected to learn how to engage patients and deliver care that aligns with their goals and preferences; the burdens on families of a patient's condition; and how to raise concerns constructively with other members of the health care team. She noted that when her son was showing symptoms, the nurses who cared for him were afraid to challenge the pediatrician who had discharged him without a bilirubin test. Ms. Sheridan questioned whether the system is organized to ensure safe, high-quality care. She pointed out that patients are best situated to determine what constitutes true patient-centered care.

Through the internet, Ms. Sheridan found other parents, mostly mothers, who were eager to educate others and advocate for better policies. They created a nonprofit organization that has developed education for clinicians, medical residents, and nurses; advocated for policy change at the national level; and collaborated with medical schools. Without the efforts of these educators, said Ms. Sheridan, there would have been no change in education or policies.

The literature clearly indicates that patients want to be involved in their care. When patients deliver education, it has a lasting impact on learners' technical skills, interpersonal skills, empathy, and development of an individualized approach to care. The push to include patients in learning has many benefits and few disadvantages, and it is happening around the world. Ms. Sheridan called on the PACCARB and others to integrate patients as educators into IPE curricula; identify champions; connect with local, national, and international patient groups; and prioritize a health care issue to rally around. She concluded that patients provide context in a tangible, palpable, enduring way that textbooks and lecturers cannot.

DISCUSSION

Asked how Cooperative Extension Program can help build scientific literacy in communities, Dr. Rennekamp said that in some universities, oversight of the extension program sits at the level of a vice president or provost and reaches across disciplines. Kentucky, for example, has fine arts extension agents. Extension offices can leverage the influence of professionals within communities and engage volunteers and paraprofessionals from the community to increase their impact. The role of young people as ambassadors should not be overlooked. Dr. Blaser said it is time to use the trust that the Cooperative Extension Program has built for over a century. However, Dr. Rennekamp also stated that the system assesses its brand awareness every 10

years, and awareness has been declining since 1980, particularly as more people move into urban areas.

Regarding population health, which combines social sciences, agriculture, and food safety, among other fields, Dr. Wamsley said that teaching systems thinking is the first step toward improving population health. More institutions should think about partnering with schools of public health and other organizations to care for the community at large.

Ms. Sheridan said medical education is beginning to recognize the need to understand the whole ecosystem of care. Patients are skilled at becoming partners, she noted, and in Europe, patients can get training and tools to do so. Without the patient perspective, medical education is incomplete, and the United States is lagging in incorporating patient perspectives, although there has been more interest in recent years in integrating patients into IPE. Ms. Sheridan added that the PACCARB and others have the influence to elevate the issue and push for systematic integration.

Panel 6: Institutional Drivers of Change

The Role of IPE in Veterinary Education About AMR

Trevor Ames, D.V.M., M.S., DACVIM, University of Minnesota

The University of Minnesota's One Health curriculum, which serves as the template for IPE at the university, aims to promote collaborative practice in real-world settings and occurs across three phases: orientation to IPE, necessary skills, and expertise in practice. Learning takes the form of structured activities designed to be embedded in courses.

Across health professions, attention to IPE standards as a function of accreditation varies greatly. The American Veterinary Medical Association's (AVMA's) Council on Education, for example, does not specifically address AMR. The World Organisation for Animal Health's (OIE's) competencies for veterinary college graduates do. The University of Minnesota was the first program to modify its curricula to meet the OIE competency requirements.

Through a joint effort of USDA and the National Veterinary Accreditation Program, 80 percent of licensed veterinarians are USDA-accredited to perform certain duties. Continuing education for maintaining accreditation includes a module on antimicrobial use in animals. Dr. Ames said that module could be incorporated into the orientation for initial licensing to enhance awareness among veterinarians. The North American Veterinary Licensing Examination touches on antibiotic resistance and residues.

Dr. Ames stated that changing accreditation standards or requirements would influence the education of the greatest number of students. Curricular content and emphasis can also be influenced by recommendations or standards of international organizations, U.S. governmental agencies, and the domains of competency for testing by national examining bodies.

International Harmonization of Accreditation Standards

Karen Martens Brandt, D.V.M., AVMA

Dr. Brandt emphasized that accrediting bodies tend not to be prescriptive but rather allow for flexibility and innovation to support continuous quality improvement. AVMA's Council on Education believes colleges can meet standards in multiple ways. Graduates should be able to demonstrate the skills needed to practice in their fields.

AVMA is a founding member of the International Accreditors Working Group for veterinary education organizations, which makes nonbinding recommendations, such as increased harmonization, that each member organization can consider implementing. Few standards mention AMR or IPE, but some require competency in antibiotic prescribing and stewardship. In principle, AMR is covered in curriculum and outcome assessment standards. There is also an expectation that curricula address the contribution of veterinarians to public and professional health care teams.

Institutional Drivers of Change: Opportunity and Evolution in Continuing Education

Graham McMahon, M.D., M.M.Sc., Accreditation Council for Continuing Medical Education (ACCME)

Dr. McMahon described the ACCME's role in accrediting approximately 1,800 medical schools and hospitals. He said it is tempting to create mandates to spur change, but that is not effective. Working IPE into graduate education might be premature, as learners will follow the example that leaders set. Until health care professionals demonstrate how teamwork leads to improvement, the field will not change.

Leadership skills—setting a clear, engaging vision; creating a culture that rewards learning; and supporting team-based processes—can be taught. Most people need to learn how to work together effectively, sacrificing some control for the benefit of the community. Good leadership recognizes individuals' psychological need for safety, accountability, and a sense of belonging. An environment of learning offers feedback that helps learners build their skills. Dr. McMahon listed a number of approaches to learning teamwork that reflects the various principles of IPE described by previous speakers.

Interprofessional continuing education connects the needs of patients and communities with opportunities for skill development that feeds into collaborative practice and, ultimately, leads to improved outcomes. Through ACCME's joint accreditation program, interprofessional communities set standards together in an effort to improve the system as a whole. Joint accreditation seeks to:

- eliminate discrepant requirements between profession accrediting bodies,
- promote and incentivize organizations to develop interprofessional continuing education and team-based learning,
- decrease the burden on organizations that are already multiply accredited,
- increase congruence between accreditation standards across the professions, and
- demonstrate the ideals that regulators put forth: respecting colleagues and sacrificing autonomy and control for the common good.

Effective interprofessional continuing education is designed by the team, for the team, and includes outcomes that take team performance and communication into account. Teams that learn together perform together Dr. McMahon concluded.

Mechanisms for Furthering IPE and the Role of Government

Donald M. Berwick, M.D., M.P.P., Institute for Healthcare Improvement

Dr. Berwick stressed that relying on inspections (e.g., to meet accreditation requirements) does not improve systems; creating learning organizations does. Tackling AMR is the kind of goal best served by supported learning. Change requires (1) a recognition of the need for change plus the will to work toward change, (2) ideas for doing things differently, and (3) execution of those ideas. Dr. Berwick said that accredited IPE represents a better way to work.

The downside of pursuing change through standards and accreditation is that there will always be people trying to game the system. Maintaining accreditation requires a lot of energy and time from busy people, and the health care field is already overburdened with requirements. If regulators lose touch with what is happening on the ground, the accreditation and maintenance processes can work against the goals of continuous improvement. In the context of IPE, Dr. Berwick suggested looking at how to use accreditation to nurture authentic relationships, rather than just achieve compliance. To measure the effectiveness of IPE, Dr. Berwick proposed cultivating collaborative networks, because systems will learn better together than separately. Convening people across organizations, fields, and location is effective.

Dr. Berwick observed that Medicare contributes \$13 billion per year to postgraduate medical education but has not exercised authority over how this funding is applied. He encouraged the Council to pursue making AMR a topic of continuing medical education through Medicare postgraduate education.

DISCUSSION

Dr. Blaser pointed out that variation in prescribing practices is a big driver of antibiotic overuse. He asked how to build an accreditation system that incorporates best practices to minimize variation. Dr. McMahon emphasized focusing on the desired outcomes, giving organizations the flexibility to educate and implement policies in any way as long as they demonstrate those outcomes. Within that process, it is necessary to develop relationships with the organizations to build trust and allow them some room to innovate and fail. A trusting relationship also allows the accreditor to provide feedback and advice on how to improve.

Dr. Berwick said that when accreditation focuses only on rooting out unacceptable practices, organizations make only minimal improvement. Focusing on helping organizations learn is more effective than looking at the final product to assign blame (or reward). Large collaborative networks can demonstrate how to put learning processes into place with transparency, and the most successful institutions within those networks can identify teachers and mentors whose ideas will spread. Transparency allows people to see how change over time improves outcomes.

Dr. King asked how the concepts of One Health and IPE are perceived within universities and among professionals. Dr. Ames responded that those working toward IPE aim to create graduates who are confident working in team-based, collaborative care settings. The concept of One Health

does not carry much weight in the health care setting but resonates in academic and global health settings. Pandemics are an opportunity to demonstrate the benefits of bringing veterinarians, public health professionals, health care providers, and others together, which underscores that the circumstances for collaboration matter.

Dr. Apley observed that learners are exasperated by education about judicious use of antimicrobials and antibiotic stewardship that do not seem to be immediately clinically applicable. Dr. McMahon agreed that adult learners must see information as relevant to their situations. He said case studies help people identify meaningful scenarios, make decisions, practice skills, and get feedback. Time for self-reflection is a key component of adult learning that leads to behavior change, he noted.

Dr. Berwick added that an educator can ask learners what they think they need to know and whether the educational material or approach is effective. When the learner does not demonstrate learning, it is often because the system does not actually allow them to apply the lessons learned. Dr. Berwick suggested looking at the systems that reward or prohibit antibiotic stewardship.

Asked to provide an example of how collaborative networks fostered good outcomes, Dr. Berwick said a collaboration between HHS and about 100 organ transplant centers sought to elucidate the reasons for the wide variation in harvesting and use of organs. The centers began teaching each other. Within 6 months the number of transplants went up dramatically. Peer-to-peer exchange is always more effective than a third-party, didactic approach, Dr. Berwick noted.

Dr. Plummer observed that there appears to be no incentive for collaborative behavior. Dr. Berwick stated that an institution's governing body is responsible for the culture. Dr. McMahon said that 120 organizations have received ACCME's joint accreditation status. The process of creating joint accreditation forced ACCME and others to model collaboration, and it has been transformational. Dr. Berwick added that a collaborative environment is self-reinforcing, because it is a better place to work.

Dr. Ames noted that the University of Minnesota brought together deans from all the health science schools, who agreed to work toward changing the culture to promote IPE. Then they decided that IPE would be delivered through experiences, not specific courses, and that those experiences would be embedded in all the health science programs, so the deans do not worry that their schools are losing tuition dollars to a separate IPE program. The first steps required institutional commitment and cultural change, as well as some seed funding, but maintaining IPE is now a matter of administrative management.

Public Comment

Kevin Kavanagh, M.D., of Health Watch USA said the United States' response to COVID-19 was far from optimal and exposed major flaws in the healthcare system, demonstrating with a harsh reality the transformations required to prevent the next pandemic. The country needs a robust public health system for surveillance, case tracking, and universal mandatory reporting of all dangerous pathogens. Public health has not been a high priority in the United States, said Dr. Kavanagh. Public health strategies controlled the COVID-19 pandemic in New Zealand, Australia, and South Korea. The United States needs a massive expansion of its laboratory

testing system and infrastructure, including genomic surveillance, because without the ability to detect carriers, spread of disease cannot be controlled.

Dr. Kavanagh said the United States' approach has been to not look for the data and to publicly deny the problem, hoping it will miraculously go away, as exemplified by the lack of mandatory reporting of health care worker acquisitions of resistant bacteria and by a flawed metric for reporting COVID-19 hospital-acquired infections. The PACCARB should develop a transformative plan that does not perpetuate ineffective strategies of the past. The public health system must not only perform comprehensive surveillance for all dangerous pathogens but also determine a patient's microbiome to tailor patient-specific interventions and to collect data for public health community strategies. Only then will the country be ready to detect and confront the next pandemic. Several lessons must be learned from the COVID-19 pandemic and applied to all dangerous pathogens. First, "one size does not fit all" is not an excuse for inaction. It did not work with MRSA, and it led to a disastrous, uncoordinated, whack-a-mole approach with COVID-19. Second is the importance of surveillance and isolation. As with MRSA, the United States neglected the identification of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) community carriers with disastrous results, leading to early undetected spread of the pandemic throughout the State of Washington.

Strong federal coordination, along with surveillance and isolation strategies are needed. Dr. Kavanagh said the government's approach to pandemics is stuck in the 1800s. He called for a national reporting system that is comprehensive for all dangerous pathogens, mandatory for all types of health care facilities and practices, accessible in real time, and available to the public the same or next day.

Kalvin Yu, M.D., of Becton Dickinson & Co. referred to a study showing that 68 percent of COVID-19 patients were prescribed antimicrobials, compared with 46 percent of those who were COVID-negative, highlighting antimicrobial use patterns and the need for stewardship. His company recently published the prevalence of macrolide-resistant *Streptococcal pneumoniae*. There is a high rate of azithromycin use in COVID-19 patients and in suspected cases; the publication highlights U.S. geographic regions with 20-percent to more than 30-percent resistance of *S. pneumoniae* in inpatient and outpatient respiratory blood isolates, a sobering statistic for those who treat community-acquired pneumonia, said Dr. Yu.

Through webinars in collaboration with the American Hospital Association, Becton Dickinson is providing insights from front-line experts during the COVID-19 pandemic from an antimicrobial stewardship and infection prevention program standpoint. It is also trying to reach more people, including nonclinicians, through podcasts. The company partnered with the Center for Infectious Disease Research and Policy on a podcast called Super Bugs and You, which had more than 3,000 downloads in its recent rollout. The podcast brings stories from people from various countries and a range of occupations who have suffered from, treated, and researched the effects of drug-resistant infections.

Discussion and WG Next Steps

Elaine Larson, Ph.D., RN, and Paul Plummer, D.V.M., Ph.D., DACVIM, DECSRHM, WG Co-Chairs

Dr. Blaser said the concept of forming national collaboratives across organizations and disciplines surfaced in presentations throughout the meeting. Such collaboratives can develop models, promote best practices, and promulgate the fundamentals of science that underlie AMR. He also pointed out the need to understand why antibiotic prescribing differs by population.

Dr. Larson said the presentations highlighted the importance of shared culture and values across disciplines, which is vital to a coordinated approach to AMR and antibiotic stewardship. Institutional commitment is particularly important, and sustainability of IPE is not related to external funding. Although accreditation and regulation can motivate people to change behavior, an experiential approach—such as hearing from patients about disjointed, uncoordinated care—is a more successful internal motivator for change.

Dr. Apley appreciated the attention to IPE but hoped to see more outcomes data before the Council makes recommendations. Dr. Plummer said that without such data, it might be appropriate for the Council to outline the desired outcomes and recommend that mechanisms be developed to achieve them.

Dr. Plummer noted that within veterinary medicine, there is little attention to the role of technicians, nutritionists, and others (outside of food animal production). He hoped the WG would consider in its deliberations those relationships, the need for a common language across disciplines, and the fundamentals of good professional relationships as a foundation of professional identity. Dr. Plummer further noted that changing culture takes time. In the meantime, it might be necessary to consider potential positive and negative incentives.

Dr. Cray asked for information about IPE programs in other countries. She suggested gathering the information into a repository for use by others.

Armando Nahum praised Ms. Sheridan for highlighting the role of patients in education. He noted that the patient's voice and perspective are vital to the Council's goals.

Michael Craig offered to provide the Council an update on a pilot project under CDC's Antibiotic Resistance Laboratory Network looking at environmental resistance patterns of *A. fumigatus* related to use of azoles. The study seeks to determine the relative burden of resistance on human infection.

Dr. Kester said the Council's recommendations should direct those with more expertise in IPE to determine how to evaluate the outcomes of proposed programs. It is also important to build mechanisms for assessment into activities, such as educational courses and team projects.

Dr. Ginocchio noted that the transition to IPE in human and veterinary medical education has been highly successful and sustainable. One challenge is introducing the concepts earlier in education, such as at the undergraduate level. Another is sustaining the lessons learned in practice through continuing education that supports interprofessional learning. The Council could recommend creative programs or novel funding mechanisms to support both.

Dr. Newland pointed out that financial, competitive pressures on U.S. hospitals and health care systems can prohibit collaboration. The Council should consider what data are available and how to incorporate them into recommendations.

Dr. Plummer appreciated the comment that people enjoy working in places that foster interprofessional collaboration, which helps keep momentum going. He hoped the WG would discuss how to promote collaborative opportunities. Dr. Larson said the WG would seek to develop recommendations that are feasible but also go beyond the ordinary.

Dr. King was heartened by the number of exemplary IPE programs, which he hoped would help pave the way for embedding education about AMR into curricula. More work is needed to define terms and language to foster collaboration and focus on competencies and outcomes. Dr. King appreciated the availability of the DOTI tool to measure teamwork performance. He emphasized the importance of developing the skills to lead, co-lead, and follow.

Dr. King urged the Council to think more about how to foster IPE beyond the university setting, moving it into practice, public health, and continuing education. He reiterated the notion of thinking about population care alongside individual patient care. Dr. King pointed out that organizational culture affects learning, so attention to culture is important.

Final Comments and Adjournment

Martin Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair

Dr. King thanked the WG co-chairs who organized the presentations and Council staff for their excellent efforts. Dr. Blaser echoed that thought and also thanked the presenters and participants. He adjourned the meeting at 2:48 p.m.

Appendix: Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) Members

February 10–11, 2021

PACCARB Voting Members Present

Martin J. Blaser, M.D., Chair
Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair
Michael D. Apley, D.V.M., Ph.D., DACVCP
Stephanie Black, M.D., M.Sc.
Helen W. Boucher, M.D., FIDSA, FACP
Sara E. Cosgrove, M.D., M.S.
Paula J. Fedorka Cray, Ph.D.
Christine Ginocchio, Ph.D., MT
Locke Karriker, D.V.M., M.S., DACVPM
Kent E. Kester, M.D., FACP, FIDSA, FASTMH
Elaine Larson, Ph.D., RN
Ramanan Laxminarayan, Ph.D., M.P.H.
Armando Nahum
Paul Plummer, D.V.M., Ph.D., DACVIM, DECSRHM
David White, M.S., Ph.D.

Organizational Liaisons Present

American Association of Extension Veterinarians
Carla L. Huston, D.V.M., Ph.D., Dipl. ACVPM

American Veterinary Medical Association
Joni Scheftel, D.V.M., M.P.H., Dipl. ACVPM

Biotechnology Innovation Organization
Greg Frank, Ph.D.

Direct Meds, Inc.
Munr Kazmir, M.D.

Pediatric Infectious Diseases Society
Jason Newland, M.D., M.Ed.

Society of Infectious Disease Pharmacists
Elizabeth Dodds Ashley, Pharm.D., M.H.S., FCCP, BCPS

Wellcome Trust
Timothy Jinks, Ph.D.

Regular Government Employees Present

U.S. Department of Health and Human Services

Mark Albrecht, Ph.D. (for Christopher Houchens, Ph.D.), Biomedical Advanced Research and Development Authority, Office of the Assistant Secretary for Preparedness and Response (*day one*)

Marjory Cannon, M.D. (for Shari Ling, M.D.), Centers for Medicare & Medicaid Services (*day two*)

James Cleeman, M.D., Agency for Healthcare Research and Quality

Michael Craig (for Rima Khabbaz, M.D.), National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention (*day two*)

Dennis M. Dixon, Ph.D., National Institute of Allergy and Infectious Diseases, National Institutes of Health

Lynn Filpi, Ph.D. (for Lawrence Kerr, Ph.D.), Office of Pandemics and Emerging Threats, Office of Global Affairs

William Flynn, D.V.M., Center for Veterinary Medicine, Food and Drug Administration

Rima Khabbaz, M.D., National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention (*day one*)

Anita Sheoran, Ph.D. (for Christopher Houchens, Ph.D.), Biomedical Advanced Research and Development Authority, Office of the Assistant Secretary for Preparedness and Response (*day two*)

U.S. Department of Agriculture

Emilio Esteban, D.V.M., M.B.A., M.P.V.M., Ph.D., Food Safety and Inspection Service

Roxanne Motroni, D.V.M., Ph.D. (for Jeffrey Silverstein, Ph.D.), Agricultural Research Service (*day two*)

Chelsey Shivley, D.V.M., Ph.D., DACAW (for Sarah Tomlinson, D.V.M.), Animal and Plant Health Inspection Service

Jeffrey Silverstein, Ph.D., Agricultural Research Service (*day two*)

U.S. Department of Defense

Paige Waterman, M.D., FACP, FIDSA, Walter Reed Army Institute of Research (*day two*)

U.S. Environmental Protection Agency

Jay Garland, Ph.D., Center for Environmental Solutions and Emergency Response

Designated Federal Officer

Jomana F. Musmar, M.S., Ph.D., Advisory Council Committee Manager, Office of the Assistant Secretary for Health (OASH), Department of Health and Human Services (HHS)

Advisory Council Staff

Mark Kazmierczak, Ph.D., Gryphon Scientific

Haley Krem, Committee Management Officer, OASH, HHS

Sarah McClelland, M.P.H., Public Health Advisor, OASH, HHS

Taylor Simmons, M.P.H., ORISE Fellow, HHS

Glossary of Abbreviations

ACCME	Accreditation Council for Continuing Medical Education
AHRQ	Agency for Healthcare Research and Quality
AMR	antimicrobial resistance
ASH	Assistant Secretary for Health
AVMA	American Veterinary Medical Association
CDC	Centers for Disease Control and Prevention
CRISPR	clustered regularly interspaced short palindromic repeats
DOTI	direct observation of team interactions (tool)
EHR	electronic health record
EPA	Environmental Protection Agency
FDA	U.S. Food and Drug Administration
HEDIS	Healthcare Effectiveness Data and Information Set
HHS	U.S. Department of Health and Human Services
ILEAP	Interprofessional Learning, Experience, and Practice (program)
IPE	interprofessional education
MRSA	methicillin-resistant <i>Staphylococcus aureus</i>
OASH	Office of the Assistant Secretary for Health
OIE	World Organisation for Animal Health
PACCARB	Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria
SARS-CoV-2	severe acute respiratory syndrome coronavirus 2
UNT	University of North Texas
USDA	U.S. Department of Agriculture
USPHS	U.S. Public Health Service
UTI	urinary tract infection
WHO	World Health Organization
WG	Working Group